Detachment and dislocation of thermoreactive clips from sternum in late postoperative period due to misuse

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INTRODUCTION

Complications of median sternotomy include non-union, dehiscence, mediastinitis, superficial wound infection and fistula formation [1]. Following cardiac surgery, sternal wound complications occur in ~2–5% of patients [2]. There are multiple risk factors for these complications, including obesity, diabetes, renal impairment, chronic obstructive pulmonary disease, steroids, advanced age, osteoporosis, smoking and harvesting bilateral internal mammary arteries [3, 4]. During routine sternal closure, five to nine interrupted stainless steel wires are used in many cardiac surgery centres. However, in some centres, interrupted stainless sutures are structured as the figure-of-eight configuration to achieve osseous apposition of the two hemi sternums. The narrow contact surface and the disparity of density between bone and steel wires may tear the bone during apposition of two parts of the sternum, especially in older patients when osteoporosis is more prevalent.

Another problem in this regard is the rupture of steel wires during excessive movement in young patients. We can briefly emphasize that the narrow contact surface and disparity of density may cause sternal tears in older patients and wire ruptures due to excessive movement in younger patients.

Excessive movement of the sternum, which may result in sternal dehiscence, may also be seen in pathological conditions, such as lower respiratory tract in infections or chronic obstructive pulmonary disease, etc. To prevent sternal dehiscence in those patients, an alternative method for sternal closure is devised using thermo clips, which distribute the pressure over a wider area as the clips have a greater contact surface [5]. Furthermore, their thermoreactive properties allow the clips to be slightly loose at insertion to allow an accurate positioning followed by auto-tightening induced by body temperature, ensuring good osseous apposition [6]. In this study, we report a misuse of thermoreactive clips in a high-risk patient.

CASE REPORT

A 44-year old diabetic man, who underwent three re-operations for sternal dehiscence after undergoing coronary artery bypass graft surgery, presented to our department with sternal dehiscence, wound infection and serous discharge from upper half of the incision. During respiration, there was air inflow and outflow from the anterior mediastinum through the sternal bone defect, which was 1.5 × 1 cm in size.

After the patient had been admitted, chest X-ray in the anteroposterior orientation revealed that one of the four nitinol clips that were used during the last revision was dislocated and the next three clips were superposed at the level of the xiphoid process (Fig. 1a). All the clips were detached from the sternum. In a lateral view of the chest X-ray (Fig. 1b), the three superposed nitinol clips were clearly identified at the level of the xiphoid process. The patient’s medical treatment was adjusted, and tissue cultures were found to be clean for three times. After then, the patient was recommended for a fourth sternal revision.

During the operation, the first clip was found dislocated from sternum to the intercostal space, and the next three nitinol clips were dislocated at the sterno-xiphoid level. We concluded that all of them were oversized. When the sternum is fixed with clips...
of a suitable size, the clips may dislocate only due to erosion of the intercostal faces of the bone or when the bone is fractured. No erosion or fracture of the sternum was encountered.

Moreover, the transverse diameter of the clips was nearly 8 mm longer than the sternal transverse diameter and the distance between the free ends of the clips was nearly the same as the sternal transverse diameter. Thus, it was inferred from having been described above that all of the clips were oversized.

The Robicsek modification technique [7] was used to prevent a new dehiscence and a new sternal revision. With this technique, vertical steel wires would reinforce the lateral free margin of the sternum and it was thought that the application of clips would be firmer (Fig. 1c).

Postoperatively, no problems occurred and the stability of sternum was excellent. The patient was discharged from our clinic at the fifth postoperative day with an excellent sternal stability.

DISCUSSION

Median sternotomy is still the incision of choice for many cardiac surgical procedures [8], and incision-related complications are not commonly encountered. According to the literature, the incidence of dehiscence is reported to be between 2 and 5% [3]. Nitinol thermoreactive clips are shown to reduce the incidence of sternal complications [3, 5]. Nitinol sternal clips (Nickel Titanium Naval Ordnance Laboratory, Praesidia, Bologna, Italy) are characterized by their shape memory and super elasticity. They become malleable at <9°C, and return to their original shape when being warmed to body temperatures due to thermoelastic martensitic transformation [5].

During sternal dehiscence repair with nitinol clips, the measurement of the appropriate clip size is the first and the most important step. The appropriate clip size must be 7–8 mm smaller than the measured size [5]; therefore, there are two ways to measure the distance between intercostal spaces, the first is the measurement using callipers and the second is the usage of Backhaus clamps.

In our case, we found that the first clip was dislocated to the intercostal space and the next three clips were dislocated to the sterno-xiphoid level. We inferred all of them being oversized. Therefore, before using these oversized clips over the sternum, we used the Robicsek modification technique to prevent a new dehiscence and a new sternal revision. With this technique, vertical steel wires would reinforce the lateral free margin of the sternum and it was supposed that the application of clips would be firmer. After this manoeuvre, clips firmly suited on the sternum.

When measuring the sternal width using the Backhaus clamp, the widest part of the clamp is positioned just above the bone. The clamp is closed to embrace the bone properly and the level of closed notches is recorded. After removing it from the bone, the clamp is closed again at the previously recorded level and the clip is chosen according to this measurement. When measuring the sternal width using a calliper, it is more difficult to embrace the bone margins properly and the connective tissue that lies between the bone and calliper can lead to wider measurements. This can be more misleading especially for inexperienced surgeons, and we believe that the measurement using Backhaus clamps is more accurate.

In conclusion, to obtain excellent results while using nitinol clips during sternal dehiscence repair, we advise our colleagues to use Backhaus clamps rather than callipers to measure the transverse diameter between the free margins of the sternum.
next to intercostal spaces, because we believe that the measure-
ment of distance using a calliper may cause oversizing, especially
in the learning curve.

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